Effects of Habitual Smoking on Aerobic Power (VO_2max)

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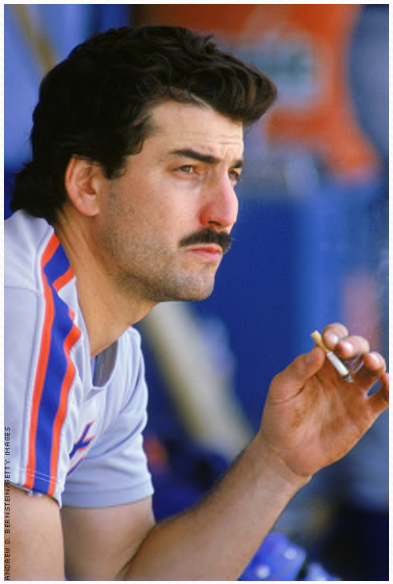
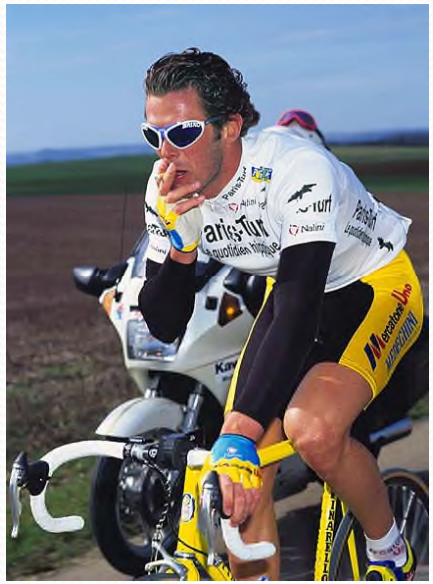
Why did my coach tell me not to smoke if so many athletes were doing it?





I took this photo of a skull I found while on patrol south of the DMZ in Vietnam in June, 1969. I copied the Surgeon General's warning from the cigarette packs we got for free in our C-rations. This hypocrisy made smoking even cooler.

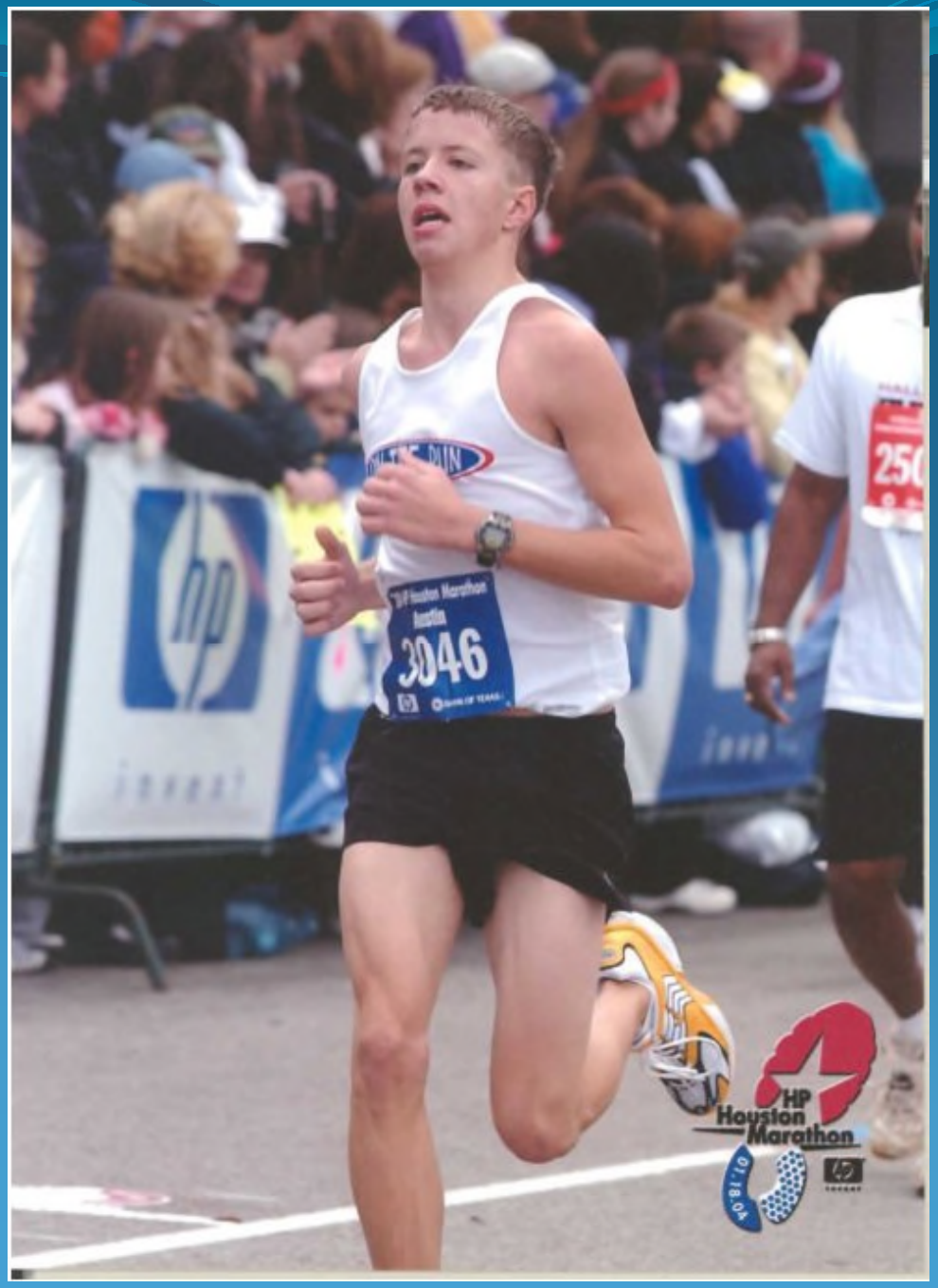
Caution: Cigarette Smoking
May be Hazardous to your
Health
Northwest of Cua Viet
Icorps RVN
June 67

What does the research say about the effects of smoking on aerobic power?

- **Most studies show smoking lowers VO_2max and exercise endurance**
  - **Due to the adverse effect of CO, nicotine and other chemicals on airway resistance, pulmonary function, ventilation, respiratory rate, O2 availability, heart rate, anaerobic threshold, cardiac output, etc.**
- **But some studies show --**
  - **No difference in VO_2max and exercise endurance for smoking and non-smoking soldiers and athletes,**
  - **Lower VO2max only for the older smokers,**
  - **No drop in VO2max even for serious smokers if they were vigorously active**

Aerobic Power

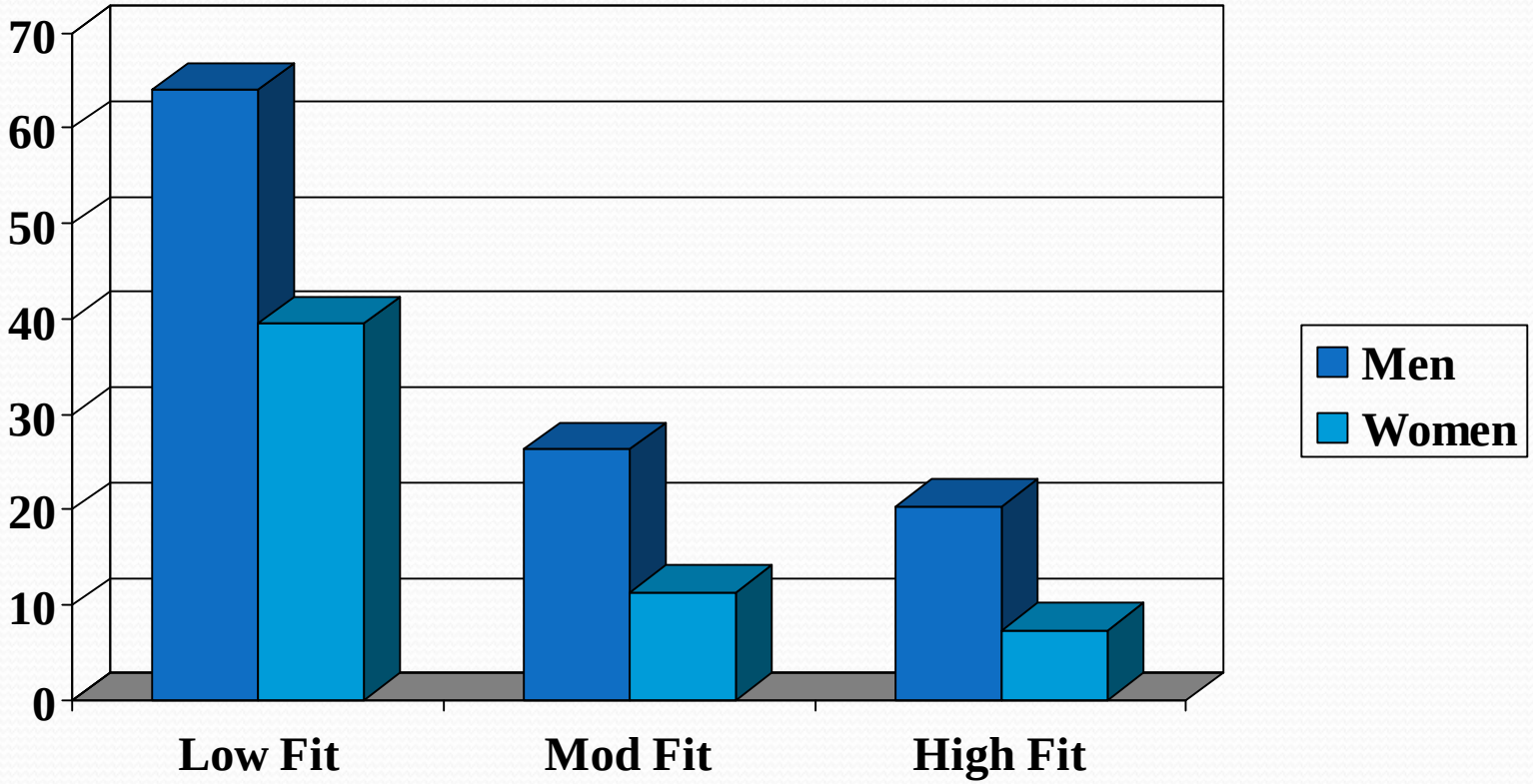
- VO_2max ($ml \cdot kg^{-1} \cdot min^{-1}$)
- Dependent on the ability of the heart, lungs, blood vessels and blood to furnish oxygen to the muscles and on the capacity of the muscles to process oxygen for long-term effort
- Best single index of physical work capacity
- Key component in health-related fitness



Aerobic Power and All-Cause Mortality

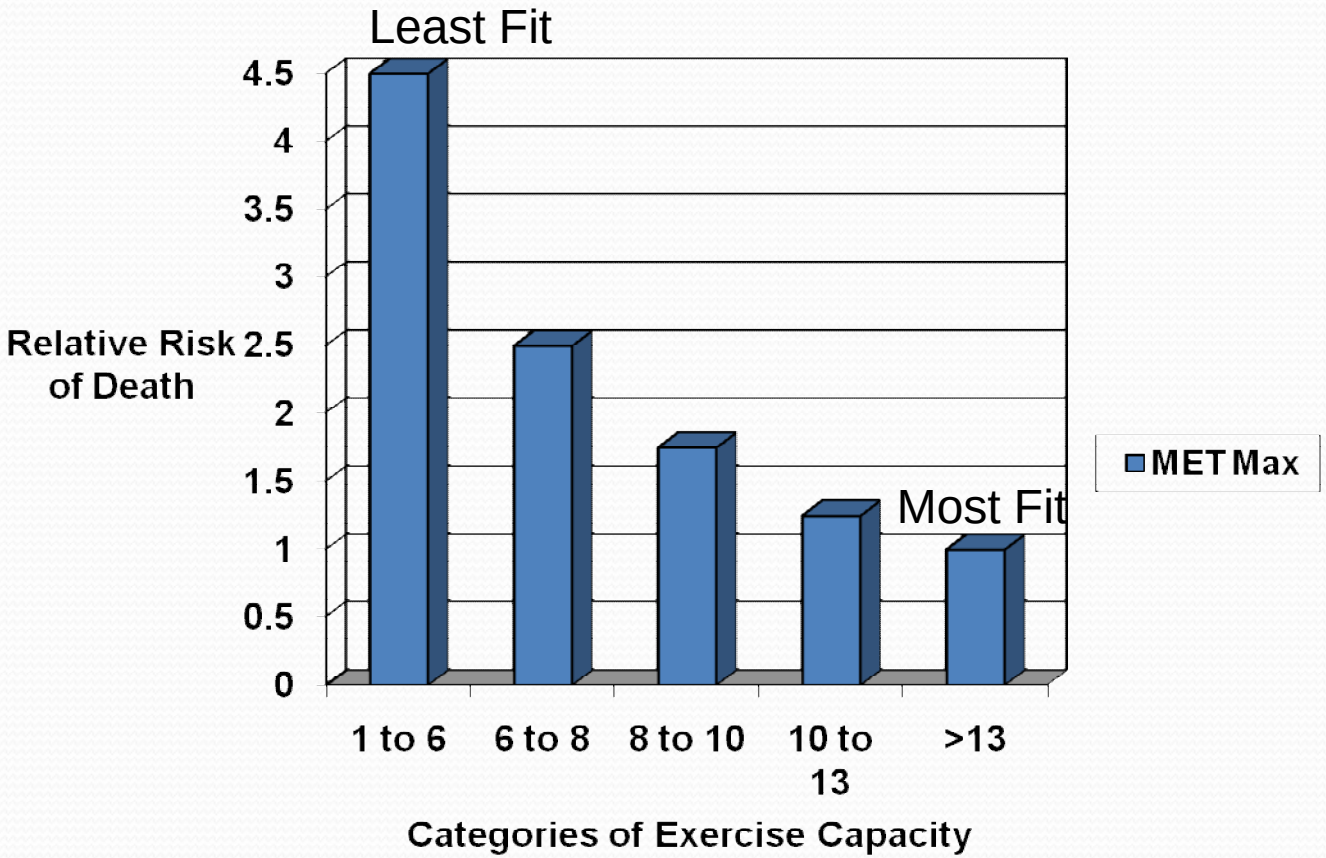
Per 10,000 person-years

(Blair, S. H. Kohl, R. Paffenbarger, D. Clark, K. Cooper, L. Gibbons. Physical fitness and all-cause mortality, *JAMA*, 1989,262:2395-2401)



Aerobic Power and Heart Disease Mortality

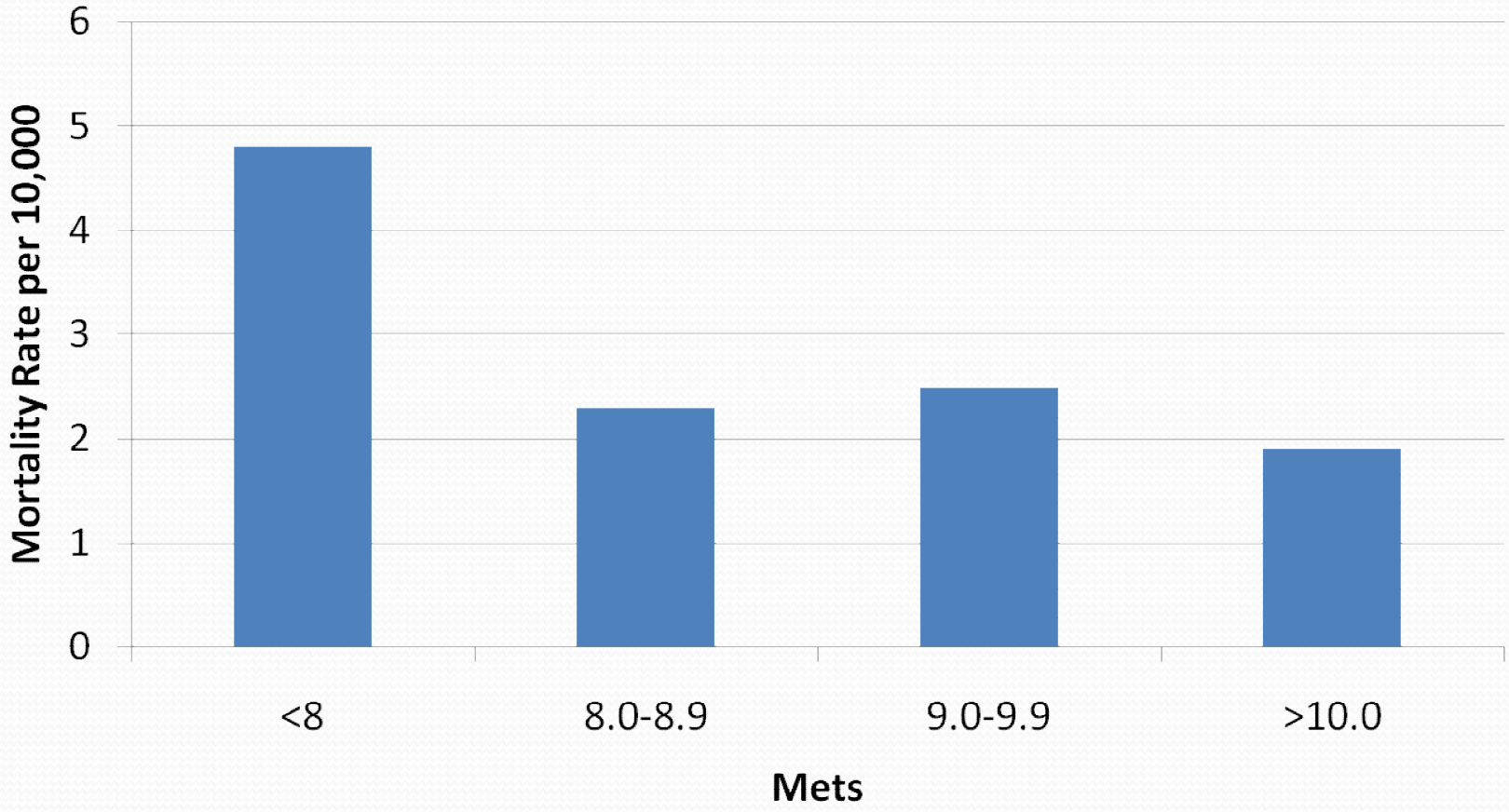
(Myers, J. Exercise and cardiovascular health. *Circulation,* 2003, 107: e2-e5)



Mortality rates are categorized by level of fitness (MET Max). Compared to the most fit, the least fit has 4.5 times higher death risk. Running/walking speed capacity : 13 METs is 7.68 min/mile; 6 METs is 16.67 min/mile; <8METs is walking.

Aerobic Power and Breast Cancer Mortality

(Peel JB, et. al. A prospective study of cardiorespiratory fitness and breast cancer mortality. *Med Sci Sports Exerc*. 2009;41 (4):742-748.)



What are the determinates of aerobic power?

- Uncontrollable
  - Heredity
  - Gender
  - Age
- Controllable
  - Training/Activity Habit
  - Body Fatness/Leanness

Tests to Determine VO_2max

- Measured by Indirect Calorimetry at maximal exertion ("gold standard")
- Estimated by –
  - Maximal tests on a Treadmill or 1.5 to 2-mile run
  - Sub-maximal tests on a treadmill, stationary bike, bench step, 1-mile walk
  - Non-exercise models

Nonexercise Models for Estimating VO_2max with waist girth, percent fat, or BMI

(LT Wier, AS Jackson, GW Ayers, B Arenare., *Med Sci Sports Exer. 2006;*38:555-561.)

	Waist Girth	% Fat	BMI
Constant	59.416*	51.936*	57.402*
Age (years)	-0.327*	-0.308*	-0.372*
Gender (M=1, F=0)	11.488*	4.065*	8.596*
Activity (0-10)	1.297*	1.217*	1.396*
Waist/%Fat/BMI	-0.266*	-0.483*	-0.683*
R	0.810*	0.817*	0.802*
SEE (ml/kg/min)	4.799	4.716	4.900
SEE%	13.393	13.161	13.675

*P<0.001

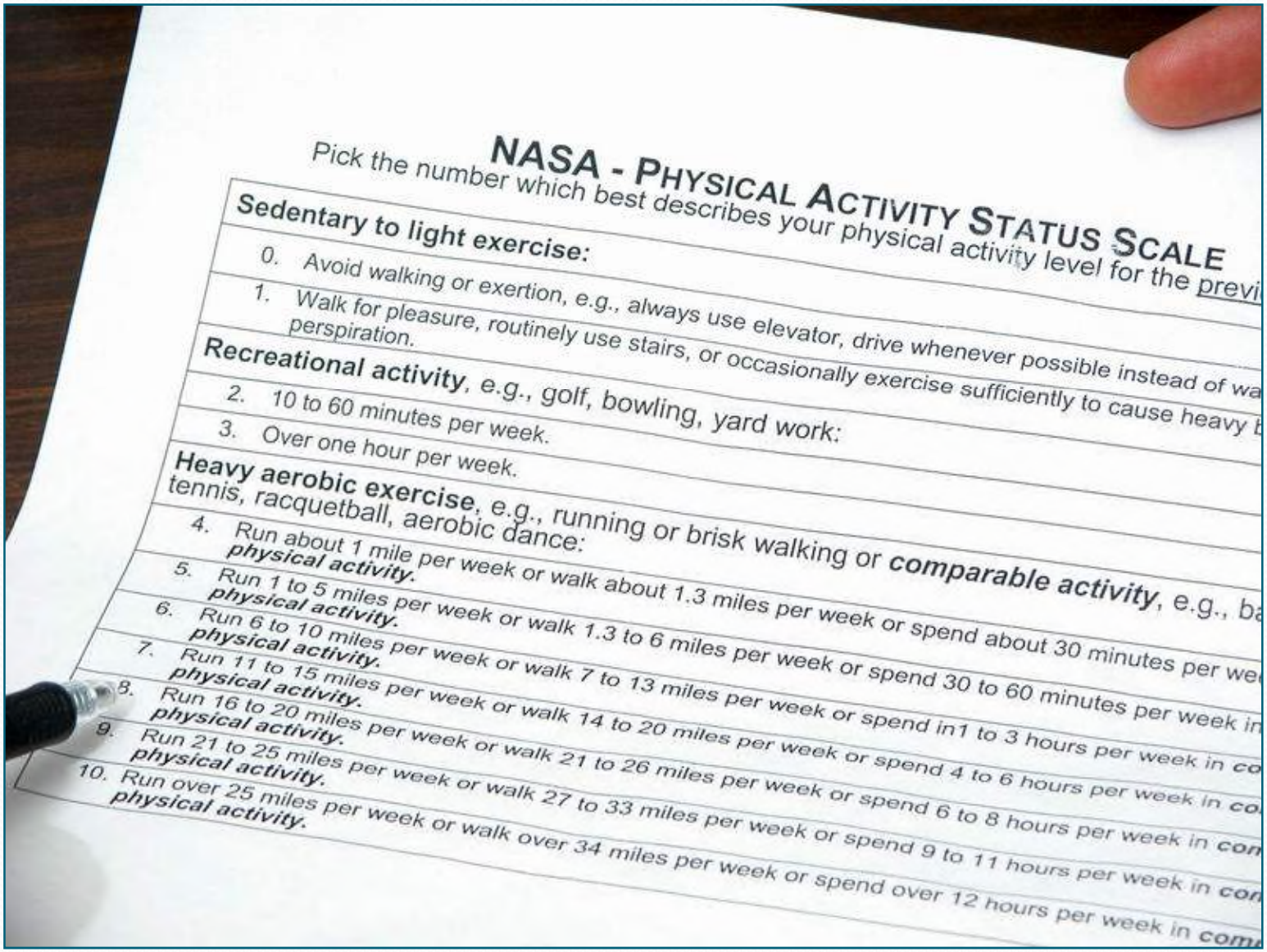
Our study on smoking and VO_2max

- Purpose: to determine the effect of habitual smoking on VO_2max after controlling for age, gender, activity and BMI

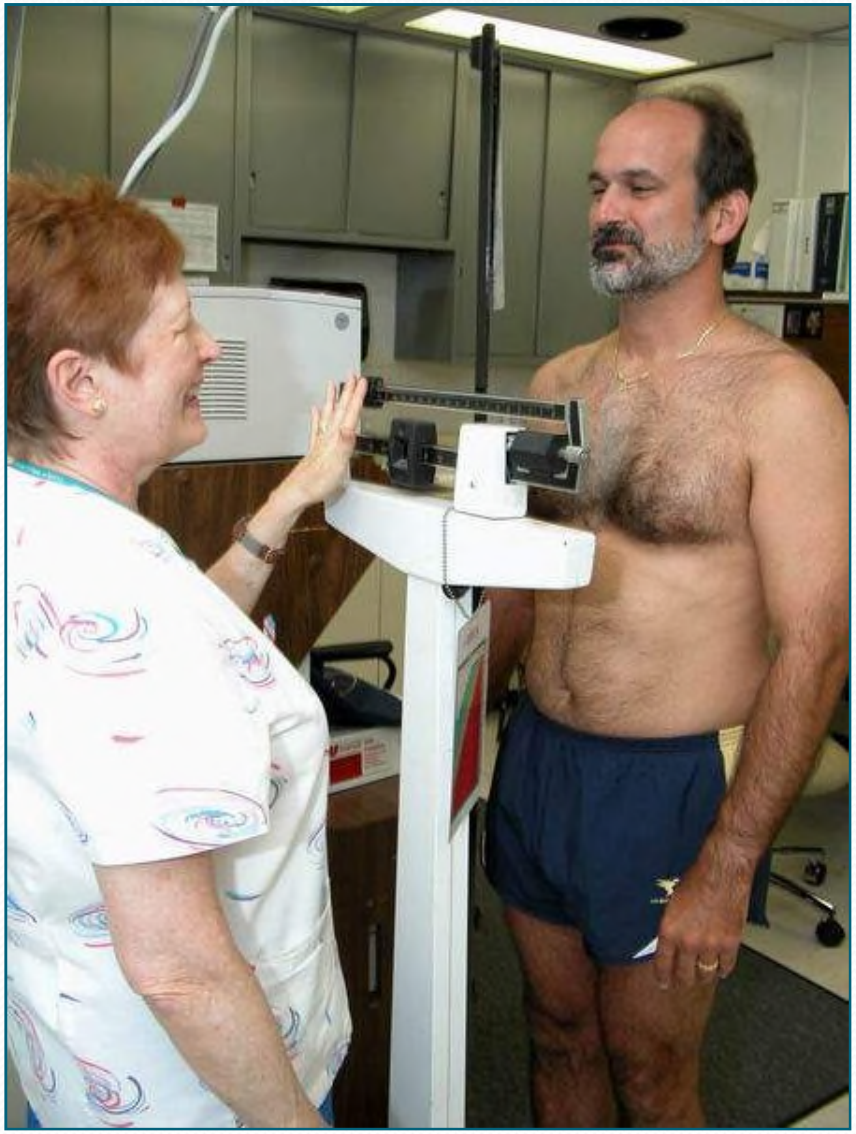
- Methods: we tested the same cardiopulmonary data used in the non-exercise model study and added smoking history (pack-years)

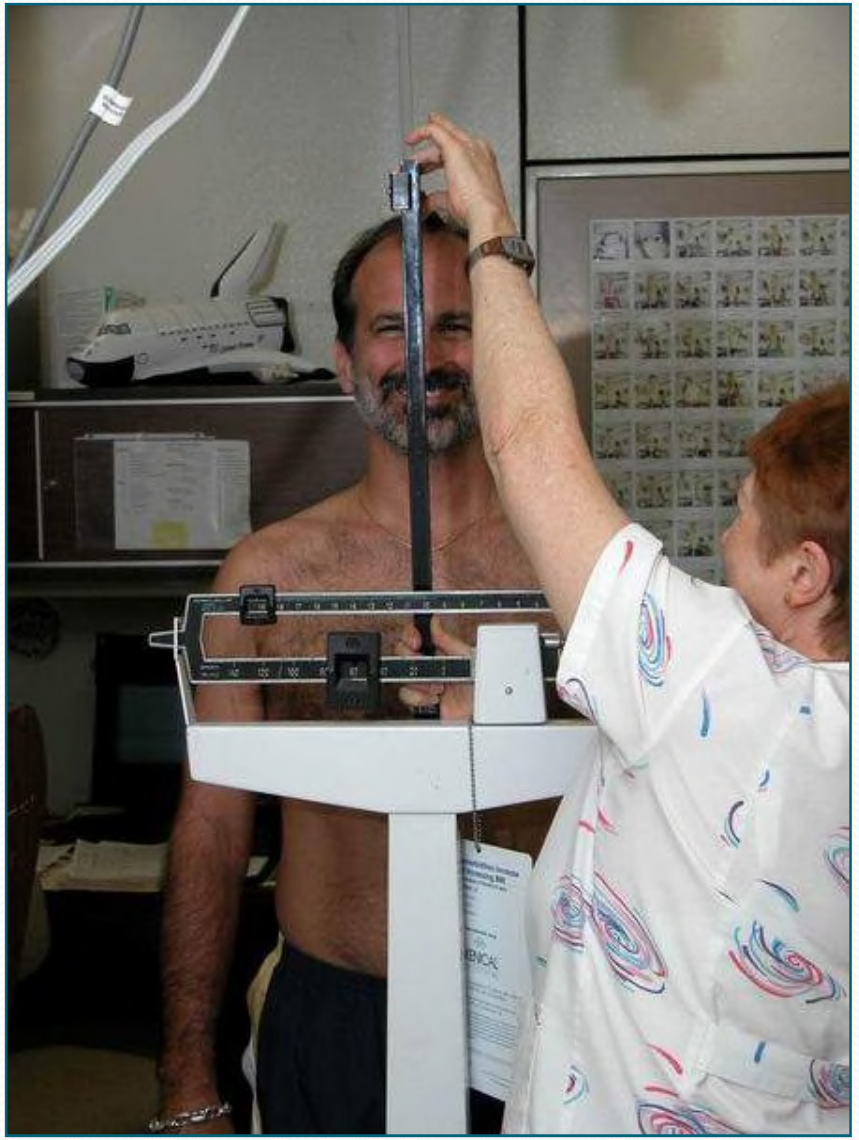
VO_2max by Indirect Calorimetry

Selecting an Activity Rating



Body Mass Index = Weight in Kg/(Height in meters)^2





Smoking Status

- Pack-years = packs per day X years of smoking
  - Example:
    - smoke 1 pack per day for 20 years = 20 pack-years
    - smoke 4 packs per day for 5 years = 20 pack-years
- Pack-year groupings
  - Never (0 pack-years)
  - Light (1-10 pack-years)
  - Moderate (11-20 pack-years)
  - Heavy (>20 pack-years)

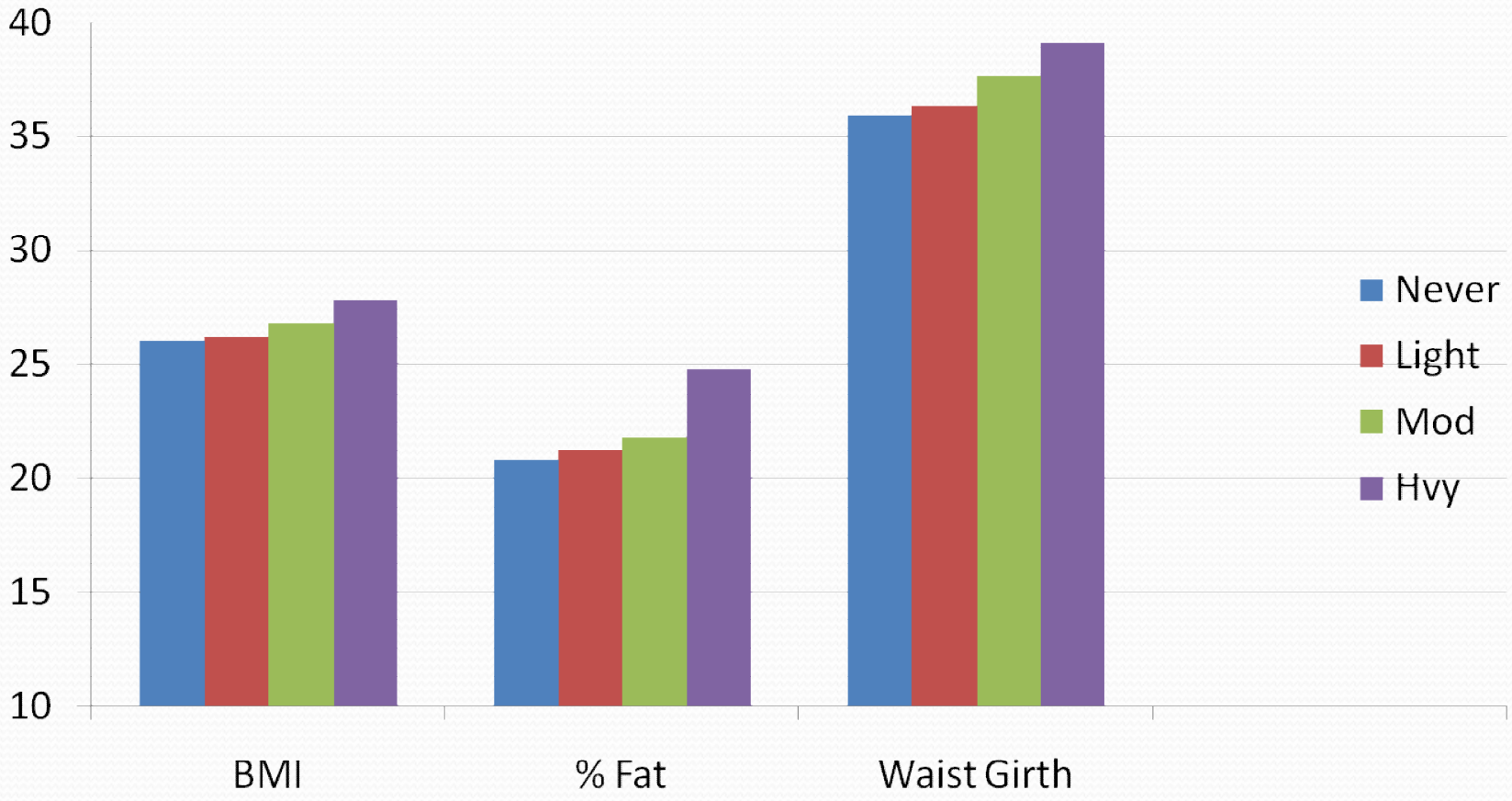
Sample sorted according to pack-years (2374 men and 375 women)

Pack-year groupings

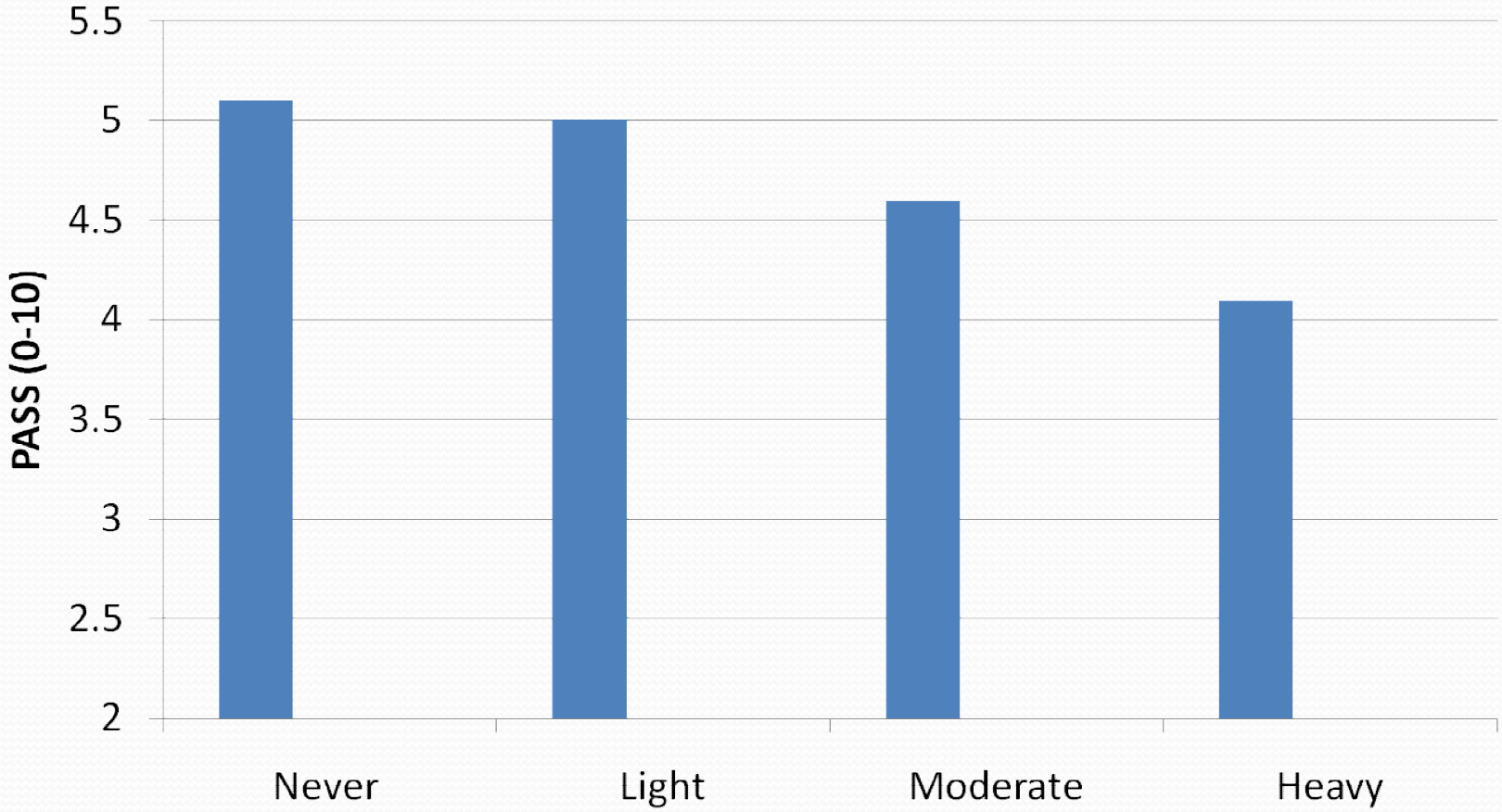
	Never 0 pk-y (n=2111)	Light 1-10 pk-y (n=331)	Moderate 11-20 pk-y (n=159)	Heavy >20 pk-y (n=148)
Pack-years	0 (0)	4.8 (3.3)	16.6 (3.2)	33.0 (12.5)
VO_2max	36.7 (8.4)	34.9 (6.2)	33.4 (6.6)	28.6 (5.5)
RER (VCO_2/VO_2)	1.2 (0.1)	1.2 (0.1)	1.2 (0.9)	1.2 (0.1)
Age (yrs)	45.4 (10.1)	46.6 (8.5)	48.6 (6.4)	53.4 (6.0)
BMI (kg/m^2)	25.0 (3.7)	24.9 (3.3)	24.7 (4.2)	26.3 (3.9)
PASS (0-10)	4.9 (2.2)	4.9 (2.1)	4.0 (2.2)	4.0 (2.5)

(Values are means with standard deviations in parentheses)

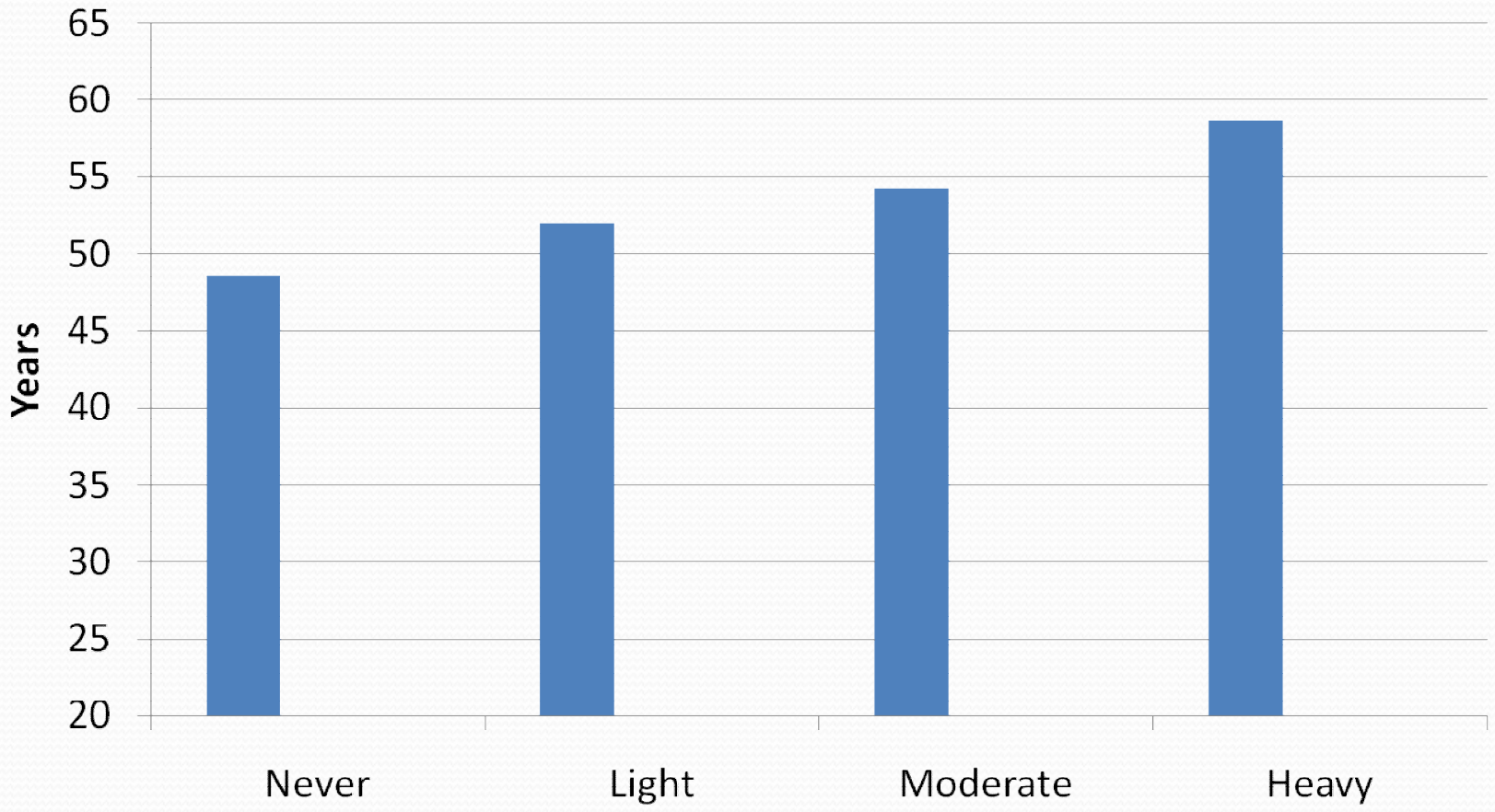
Three Expressions of Body composition of the 2,374 men sorted by smoking habit – Smokers are fatter!



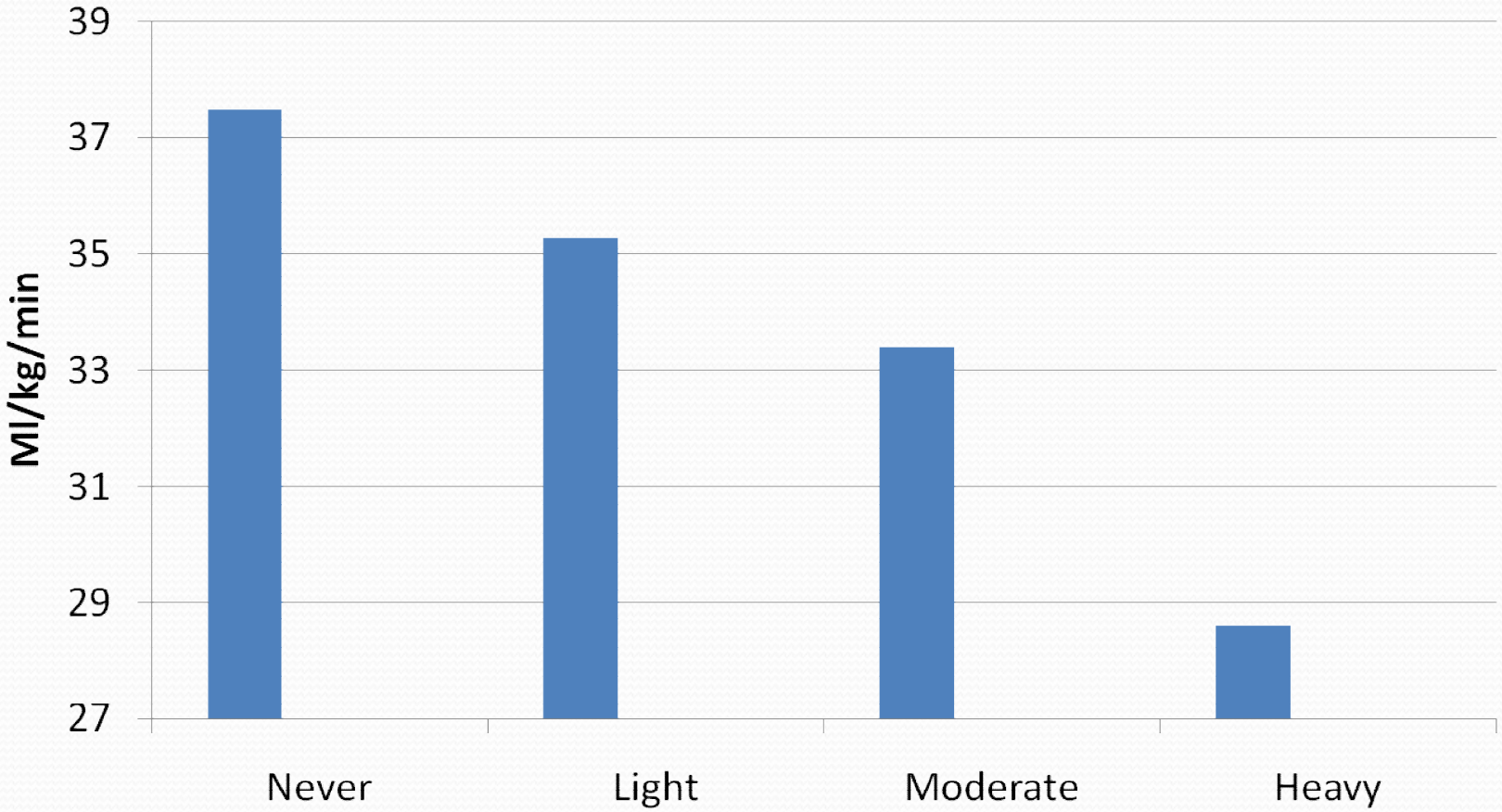
Mean Physical Activity of the 2,374 Men Sorted by Smoking Habit – Smokers are less active.



Mean Age of the 2,374 Men Sorted by Smoking Habit – Habitual smoking rises with aging.



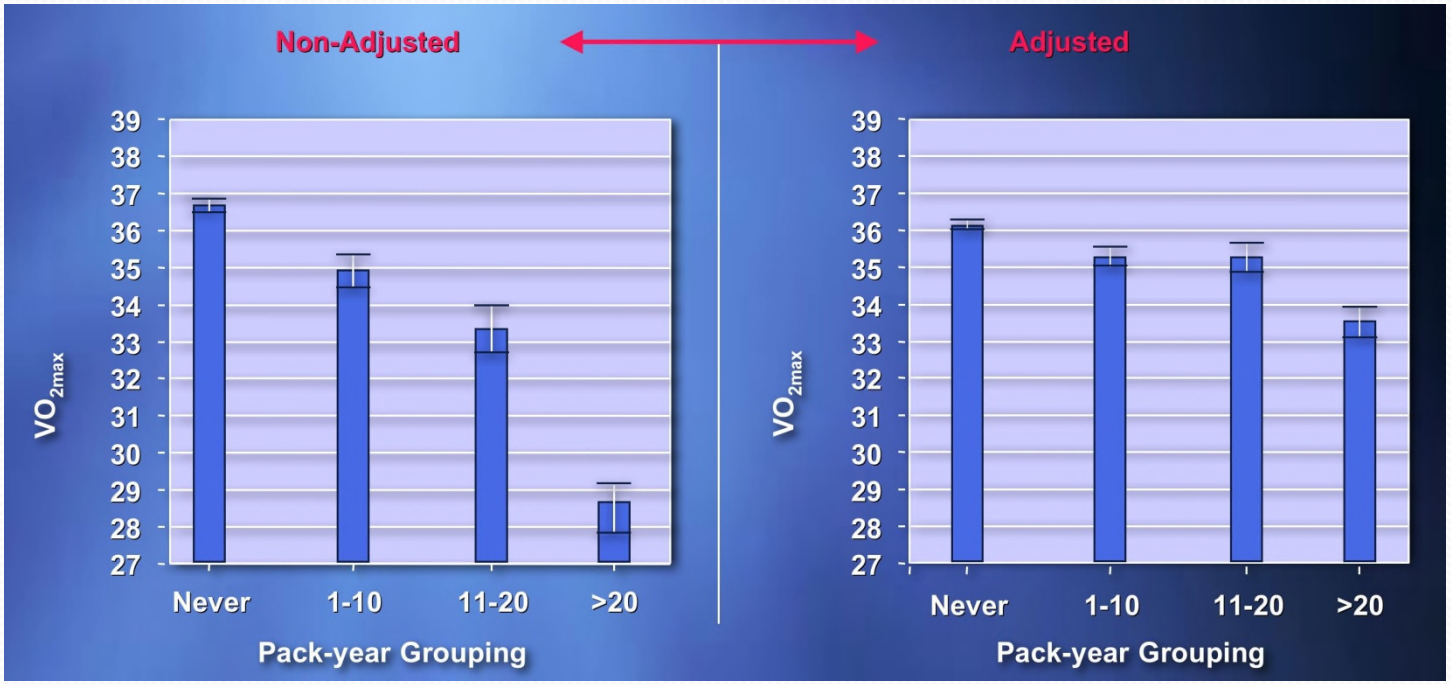
Mean VO_2max of the 2,374 Men Sorted by Smoking Habit – Aerobic fitness drops steadily with increased smoking.



But analysis of covariance shows the effects of smoking on VO_2max are attenuated by age, gender, activity and body composition

Pack-yr/VO_2 max relationship without covariance adjustment

Pack-yr/VO_2max relationship with covariance adjustment



Two Models estimate VO_2max: without and with smoking

	Without Smoking	With Smoking
Constant	57.402*	56.690*
Age (yr)	-0.372*	-0.358*
Gender (M=1, F=0)	8.596*	8.582*
PASS (0-10)	1.396*	1.392*
BMI	-0.683*	0.669*
Light (1-10 pk-yrs)		-0.833**
Moderate (11-20 pk-yrs)		-0.852**
Heavy (>20 pk-yrs)		-2.556*
R	0.802*	0.805*
SEE	4.900*	4.858*
SEE%	13.675	13.558

*P<0.001; **P<0.05

Conclusions

- After accounting for the effects of age, gender, activity and BMI the effect of habitual smoking on VO_2max is minimal until the habit exceeds 20 pack-years.
- The inclusion of smoking status improves the estimate of VO_2max for smokers (especially heavy smokers).

In other words--

- Most of the difference in the aerobic fitness of habitual smokers compared to non-smokers can be explained by the fact that smokers tend to be fatter and less active.
- The fitness effects of smoking are slow-acting and subtle, lulling active smokers into thinking the habit does not slow them down until the habit becomes very serious and fitness plummets
- It takes a high amount of smoking and a long time for the effects to become apparent, but the effects can also be deadly